

## Claims

- [c1] 1. A motor controller for a motor-driven pump, the controller having at least one voltage sensor and at least one current sensor and configured to:  
receive a voltage and a current signal of the pump in operation from the at least one voltage sensor and the at least one current sensor;  
determine a power signal from the voltage signal and the current signal;  
generate a real-time spectrum analysis of the power signal; and  
determine undesirable torque conditions in the pump from the spectrum analysis.
- [c2] 2. The motor controller of claim 1 further configured to automatically provide an external indication of the undesirable torque condition in the pump.
- [c3] 3. The motor controller of claim 1 further configured to automatically disable the pump if the undesirable torque condition exceeds a threshold.
- [c4] 4. The motor controller of claim 1 further configured to apply an FFT to the power signal.
- [c5] 5. The motor controller of claim 1 further configured to band-pass filter the power signal.
- [c6] 6. The motor controller of claim 1 further configured to generate a model spectrum analysis of the pump during healthy operation and determine the undesirable torque condition in the pump by comparing the model to the real-time spectrum analysis.
- [c7] 7. The motor controller of claim 1 wherein the undesirable torque condition is defined by at least one of misalignment of the pump and mechanical interferences in the pump.
- [c8] 8. A computer readable storage medium having stored thereon a computer program to detect and signal mechanical anomalies in a motor-driven centrifugal pump and representing a set of instructions that when executed by a processor causes the processor to:  
determine an instantaneous pump motor power signal from voltage and current

data collected by one or more voltage and current sensors in a motor starter of the motor-driven centrifugal pump;  
signal process the instantaneous pump motor power signal;  
compare the processed instantaneous pump motor power signal to a pump motor power signal modeled during healthy operation of the pump motor; and  
if the processed instantaneous pump motor signal exceeds a threshold, provide an external notification signaling mechanical anomalies in the pump.

- [c9] 9.The computer readable storage medium of claim 8 wherein the set of instructions further causes the processor to perform a spectrum analysis on the instantaneous pump motor power signal.
- [c10] 10.The computer readable storage medium of claim 9 wherein the set of instructions further causes the processor to apply an FFT to the instantaneous pump motor power signal.
- [c11] 11.The computer readable storage medium of claim 9 wherein the set of instructions further causes the processor to input the instantaneous pump motor power signal to a band pass filter.
- [c12] 12.The computer readable storage medium of claim 8 wherein the instantaneous pump motor signal includes a three-phase power signal.
- [c13] 13.The computer readable storage medium of claim 8 wherein the set of instructions further causes the processor to display a spectrum analysis of the processed signal on a console.
- [c14] 14.A method of detecting mechanical anomalies in an operating centrifugal pump motor, the method comprising the steps of:  
capturing an operational model of a centrifugal pump motor assembly known to be operating normally;  
generating a baseline power signal from the modeling;  
acquiring instantaneous voltage and current signals of the pump motor assembly from voltage and current sensors in the motor assembly;  
determining a real-time power signal from the instantaneous voltage and current signals; and

determining undesirable harmonics in the real-time power signal based on a comparison with the baseline power signal.

- [c15] 15.The method of claim 14 further comprising the step of determining an undesirable mechanical condition based on a presence of undesirable harmonics in the real-time power signal.
- [c16] 16.The method of claim 14 further comprising the steps of:  
conditioning the instantaneous voltage and current signals;  
digitizing the conditioned signals;  
applying FFT to the power signal;  
outputting the transformed signal to a digital-to-analog converter; and  
displaying analog signal.
- [c17] 17.The method of claim 14 further comprising the step of delineating between a transient condition in the pump and the undesirable mechanical condition based on several cycles of undesirable harmonics in the real-time power signal.
- [c18] 18.The method of claim 14 wherein the step of acquiring instantaneous voltage and current signals includes the step of acquiring voltage and current data from at least two phases of the pump motor.
- [c19] 19.An apparatus for detecting undesirable torsional/mechanical conditions in a pump, the apparatus comprising:  
at least one voltage sensor and at least one current sensor;  
a processor configured to receive data from the at least one voltage sensor and the at least one current sensor, the processor having:  
means for determining a power signal from the voltage and current data;  
means for generating a spectrum analysis of the power signal;  
means for comparing the spectrum analysis to a spectrum analysis of a modeled power signal; and  
means for determining undesirable harmonics indicative of mechanical disturbances in the pump from the comparison.
- [c20] 20.The apparatus of claim 19 further comprising means for displaying the spectrum analysis of the power signal on a console.